

Directions: Evaluate and/or calculate as indicated.

- A snowball is melting in the hot Pasadena sun. At the moment when the radius of the snowball is 3 inches, the volume of the snowball is decreasing at $4\pi \text{ in}^3/\text{sec}$. How fast is the radius changing at that time?
- A hot-air balloon rises vertically as a rope attached to the base of the balloon is released at a rate of 5ft/sec. The pulley that releases the rope is 20 feet from the spot on the ground directly below the balloon. At what rate is the balloon rising when 500 feet of rope have been let out?
- A point is moving along the graph of $y = x^3 - 3x^2$ in such a way that the y -coordinate is decreasing at the rate of 3 units/sec (i.e. $\frac{dy}{dt} = -3$). What is $\frac{dx}{dt}$ when $x = 1$?
- A trough has the shape of the wedge shown below. Water is being poured into the trough at the rate of 2 cubic feet per minute. At what rate is the depth of the water changing when the depth is 1 foot?
- Sand falls from a conveyor belt onto a conical pile at a rate of $10 \text{ ft}^3 / \text{min}$. The radius of the base is always equal to half of the pile's height. At what rate is the height of the pile increasing when the pile is 5 feet high?
- A light is at the top of a 16-foot pole. A woman 5 feet tall walks away from the pole at a rate of 4 ft/sec. At what rate is the length of her shadow changing?
- A 13-foot ladder resting on horizontal ground is leaning against a vertical wall when its base starts to slide away from the wall. By the time the base is 12 feet from the wall, the base is moving at a rate of 5 ft/sec. At what rate is the top of the ladder moving at that time?
- $\frac{d^2 y}{dx^2} [x \cos(5x) - \sin^2(x)]$
- $\frac{d^2 y}{dx^2} \left[x \tan\left(\frac{1}{x}\right) \right]$
- $\frac{d}{dx} [x^2 y + 3xy^3 - x = 3]$
- $\frac{d}{dx} [x^3 + y^3 = 3xy^2]$

Tips: $\frac{d}{dx}[f(x)g(x)] = f(x)g'(x) + g(x)f'(x)$
 $\frac{d}{dx}\left[\frac{f(x)}{g(x)}\right] = \frac{g(x)f'(x) - f(x)g'(x)}{(g(x))^2}$

For the following find where f is increasing/decreasing, relative max/min(s), intervals of concavity, inflection points, and all asymptotes.

13. $f(x) = \sqrt{x^2 - 3x - 10}$

14. $f(x) = \frac{(x-2)^3}{x^2}$

15. $f(x) = \frac{3x}{\sqrt{4x^2 + 1}}$

16. $f(x) = \frac{x^2 - x - 12}{x + 1}$

17. $f(x) = x - x^{2/3}$

For the following find the 1st and 2nd derivatives and critical values of f on $[0, 2\pi]$.

18. $f(x) = x - \sin(x)$

19. $f(x) = (1 - 2\sin x)^2$

20. $f(x) = \sin^2(x)$

21. $f(x) = \cos(x) - \sin(2x)$

Find the Extrema and Mean Values on in the given intervals.

22. $f(x) = \cos(x); [\pi/2, 3\pi/2]$

23. $f(x) = \frac{1}{2}x - \sqrt{x}; [0, 4]$

24. $f(x) = \frac{1}{x^2} - \frac{4}{3x} + \frac{1}{3}; [1, 3]$

25. Find the extrema of $f(x) = \sqrt[3]{x^2} - x$, on the interval $[-1, 2]$